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ABSTRACT

This working paper reflects the conviction that three areas of change are needed if America's higher education system as a whole is to make optimal contributions to the economic health of the country; it is based on the premise that at this time higher education is far from fully contributing to the economic well-being of the United States. The three areas are: (1) enhancing the transfer of knowledge from creation to application and utilization; (2) providing, both in terms of quality and content, the kind of education which prepares individuals to be competent and effective in their chosen occupation or profession; and (3) offering opportunities for life-long education to ensure the maintenance of professional competencies in a time of accelerating change. Main topic headings include: higher education and the economy; industrial extension--bringing innovation to the users; a new look at education for competence; maintaining the competency of practitioners; and the federal role. (GLR)

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Higher Education and American Competitiveness

Ernest A. Lynton

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Higher Education and the Economy

This paper reflects the conviction that changes are needed in three areas if America's higher education system as a whole is to make optimal contributions to the economic health of the country.[1]

These include:

- enhancing the transfer of knowledge from creation to application and utilization;
- providing, both in terms of *quality* and *content*, the kind of education which prepares individuals to be competent and effective in their chosen occupation or profession; and
- offering opportunities for life-long education to ensure the maintenance of professional competencies in a time of accelerating change.

A common trend links the three. First, the system must become more open in instructional as well as in scholarly activities. Second, new modes of interaction are needed between the classroom, research laboratory and external world. These changes are multi-faceted and will require both major innovation as well as incremental adjustment.

The potential federal role in encouraging and supporting the necessary changes is equally diverse. Only a few of the required adjustments can be facilitated by direct federal intervention; most are either a matter of state policies or are not influenced by governmental actions. However, they are all matters of federal concern, and can be influenced at the federal level in many ways -- not the least of which is the use of the "bully pulpit" of public office.

The following is illustrative. In recent years "high technology" has become the universal slogan for economic vitality. Attention has concentrated on opening new fields in both the manufacturing and service sectors. A flood of speeches and articles in the popular press have stressed the importance of commercializing discoveries and inventions arising from research by establishing new enterprises. This has created a favorable climate of opinion, and as a result, state and federal legislators and policy makers are seeking ways to encourage these investments. Every state, and indeed almost every city, has provided a variety of incentives to create science parks and incubation centers. Both federal tax laws and anti-trust regulations have been modified. In short, once the goal was clearly articulated and widely understood, policymakers created many different ways to facilitate implementation.

At the same time, this example demonstrates the danger of focusing on a single facet of higher education's potential for economic impact and ignores others. Intense publicity about high technology and new ventures has overshadowed the need to modernize mature industries and services. Hence, little has been done to encourage and involve higher education in this effort. If both the need for this effort and higher education's potential contribution to it had been better understood, many ways could have been found to enhance a constructive federal role in this arena.

1. Ernest A. Lynton and Sandra E. Elman. 1987. *New Priorities for the University*. San Francisco: Jossey-Bass.

The basic aim of this paper, therefore, is to draw attention to the three principal changes which need to take place in higher education. It is hoped that a better understanding of these changes will contribute to the development of appropriate federal goals and guidelines.

A Long Tradition of Linkage

The connection between education and economic vitality of this country was recognized as early as the mid-1800's. Horace Mann, then Secretary to the Massachusetts State Board of Education, in 1848 described schools as "the grand agent for the development or augmentation of national resources, more powerful in the production and gainful employment of the total wealth of a country than all the other things mentioned in the books of the political economists."

In 1862, the federal government first exercised a role in higher education. The Morrill Act granted land to the states to establish colleges to "promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

Before the turn of the century, federal policymakers perceived the value of linking the results from research to application. The Hatch Act (1887) established agricultural experiment stations which applied basic science to the solution of specific agricultural problems. Federal support for the extension service of the land-grant colleges was formalized in 1914 by the Smith-Lever Act.

The current interest in higher education and economic development reflects a utilitarian view of our colleges and universities dating back to the early 19th century. Current efforts to enhance the contribution of higher education to competitiveness are based on well-established principles; however, both scale and urgency have changed.

There exists today a vastly larger -- and more expensive -- system of higher education, enrolling a much larger proportion of the population. It represents, in the aggregate, a substantial intellectual resource for teaching, research and outreach which should be fully utilized. Today's "knowledge society" requires large numbers of highly skilled individuals. Furthermore, the rate of technological change is constantly accelerating, demanding the rapid and effective dissemination of new ideas and new techniques. The benefits deriving from a scientific or technical innovation and application are far too great for a laissez-faire, trickle-down approach to the process. Higher education can contribute to the economic strength of the country, and this should necessitate a concern and involvement at both the federal and state level.

The Debate Intensifies

The emphasis on the college and university role as educators of skilled manpower, and as developers and disseminators of innovation has also intensified the perennial debate about the utilitarian, instrumental conception of higher education. The requirements have not changed since the publication of the *Yale Report* of 1828, which proclaimed "the *discipline* and *furniture* of the mind" as the paramount aims of higher education, rejecting the notion that these could be combined with the acquisition of practical experience. Now as then, a small number of voices call for a pristine maintenance of the academy. Today, Allan Bloom echoes the authors of the

Yale Report as well as Cardinal Newman, Veblen and Hutchins. These extreme views can be rejected, but they can also remind us that higher education possesses historic traditions which must be observed while responding to immediate needs. These traditions may not have any early and easily identifiable returns, yet they are as important as economically quantifiable contributions. They distinguish academic institutions from all other organizations. Indeed, colleges and universities may be the one segment in our society with a specific, but not always explicit, mandate to maintain a long-range view and provide a reservoir of knowledge and understanding necessary to prepare for the future.

It is, therefore, essential to cherish and safeguard academic autonomy, even for government-supported institutions. Federal policy and monetary assistance is needed for:

- non-directed, basic research; such activity is inherently unpredictable as to its outcomes and eventual utility, and therefore should be viewed as an essential investment in the future; and
- fields and disciplines which may not be currently popular, but whose existence is essential to the intellectual fabric of an academic institution.

Necessary Changes in Higher Education

Changing circumstances and societal needs have strengthened the link between higher education and the economy. Research in fields such as materials science, expert systems, biotechnology and genetic engineering has intensified, producing a steady stream of new ideas and new techniques. This can contribute greatly to the country's economic vitality.

Although serious flaws exist in current instructional programs, the country benefits from large numbers of individuals who are better educated and more highly skilled because they attended one of our many colleges and universities. The glass, therefore, is certainly not empty, but it is far from full.

Current efforts to increase the economic contribution of higher education are concentrated in the research universities and the community and technical colleges. Graduates of the former constitute a substantial percentage of future leadership in research, development and enterprise. In the last five years, major universities have formed partnerships with business and industry in research and development. But this process is, on the whole, limited to major corporations and the most prestigious universities. The results of this collaboration only benefit parts of the economy, and at times are not even effectively absorbed by the very industries working with universities.

At the other end of the spectrum, many two-year institutions have had considerable success in meeting regional needs for skilled manpower in entry level technical positions, but by their very nature contribute very little to meeting the demand at higher levels.

In between these extremes there exists a vast array of other colleges and universities, including

the more than 300 comprehensive and Ph. D.-granting universities. These institutions prepare the great majority of practicing engineers, supervisors and managers, financial service personnel and other entry- and mid-level professionals. Many of these universities already have close ties to their local and regional constituencies. They comprise a large intellectual resource, with several hundred thousand faculty members (most with terminal degrees) as well as substantial laboratories and libraries.

The challenge is to mobilize these institutions and their academic staff to stimulate the application of knowledge from creation to utilization, and to prepare students for senior level positions in the world of work.

Industrial Extension: Bringing Innovation to the Users

Technology Transfer

Discussions of research contributions of higher education to economic vitality have emphasized the *creation* of scientific and technical innovation and its *commercialization* through new high-tech ventures. These are only parts of a complex and challenging process needed to enhance our competitiveness.

In this information- and technology-intensive era, it is equally important to maintain the vitality of existing enterprises by ongoing modernization through absorption of new equipment and techniques. We cannot afford to abandon our neglected and eroded mature manufacturing base. We must also keep service providers at the cutting edge of innovation. In order to accomplish this, basic and applied research need to be collected, synthesized, disseminated and applied throughout both the public and private sectors of the economy. At the same time, and largely through the same channels of communication, issues and problems arising in practice need to be fed back, often to the most basic research level.

In short, we need to pay more attention to *technology transfer*, a term first used to describe the flow of innovation from industrialized to less developed countries. This concept now applies to the mature sectors of the economies of industrialized countries. The accelerating pace of technical and scientific innovation can leave existing businesses and industries -- as well as public sector agencies -- *underdeveloped*. A steady and effective transfer of new knowledge to maintain the competitiveness of our older industries is as important as creating ventures in new fields. In our competition with other industrialized countries, we lag behind not only in many high-tech fields but, also, in such sectors as machine tools and textile machinery that have failed to utilize modern technology.

In our current discussions of the contribution of higher education to American competitiveness, we tend to overlook one part of the economy in which this country has been, and continues to be, spectacularly competitive: *agriculture*. Our agriculture has remained at the cutting edge of technology, steadily improving its productivity due to a remarkable American invention in higher education: combining *agricultural experiment stations* and *agricultural extension*. This creates a close connection between sources of new knowledge and effective dissemination.

In agriculture we have recognized that ongoing technology transfer is a complex, two-way process connecting the creation of new knowledge with its ultimate application. Agricultural schools in our state universities have played a pivotal role in this process. Until recently, most of their faculty members were engaged in outreach as well as research and instruction, reflecting the close interrelationship between these three components of technology transfer. This multiple and interconnected function of schools of agriculture has been sustained by federal funds since the Hatch Act (1887) and the Smith-Lever Act (1914). The former provides support for agricultural experiment stations, the latter for cooperative extension.

The post-Sputnik availability of generous federal funds for basic research has reduced the interest of our universities in applied research and in extension activities. Although we continue to pay lip service to research, service and teaching, the tradition established in agriculture has not been extended to other areas. On the contrary, the prestige and the rewards in the academic world are all concentrated on basic research.

An Example from Abroad

In recent years West Germany and certain other industrialized nations have remembered what we have forgotten -- the need for explicit policies and procedures to enhance the transfer of new ideas and techniques from the research laboratory to where they can be used. As one U.S. corporate executive remarked recently after a visit to West Germany: "The U.S. tends to define innovation as *invention;* (Germany) defines innovation as the *application of* invention."

In West Germany, the federal and the state governments provide support for a variety of activities and organizations which constitute an effective industrial extension service. One of the states, Baden-Wuerttemberg, is a region with a substantial and thriving industrial infrastructure of small- and medium-sized enterprises. It has moved the furthest, establishing a network of complementary services and activities providing a "holistic" approach to technology transfer. The major components are:

- the Steinbeis Foundation;
- the Fraunhofer Institutes and similar entities; and
- the Chambers of Commerce and Trade Associations.

The *Steinbeis Foundation* was created in 1971 with a small amount of state funding to promote medium-sized industrial enterprises in Baden-Wuerttemberg. Because of the growing importance of technology transfer, a State Commissioner for Technology Transfer was appointed in 1982. Reporting directly to the head of the state, his role is to assist and accelerate the adaptation of small- and medium-sized enterprises to the rapid structural changes triggered by developing technologies. In 1983 the two functions were integrated. The commissioner became the head of the Foundation, and the capitalization of the Foundation was substantially increased to about DM 20 million.[2]

2. *Annual Report*. 1987. The Steinbeis Foundation: Shettgait, F.R. G.

The Foundation uses two principal transfer mechanisms:

- *Technical Consulting Services*: 16 of these units (all figures are as of the end of 1986) are located near and are loosely related to the polytechnic colleges. They provide free general informational services (state-of-the-art technologies, market conditions, sources of state and other support, etc.) and specialized consultancy on a contract basis. The latter includes technology surveys and prognoses, management consultation for new ventures, assistance in finding new products and exploiting new ideas.

- *Transfer Centers*: As soon as a substantial demand occurs for certain fields of technology, a Transfer Center specializing in that area is established in a place where the appropriate expertise exists -- at a university or polytechnic college, or in cooperation with industrial firms or state institutions. These Centers carry out applied research and development for small businesses on a contract basis, and must become self-supporting after two years. Currently, 48% of their revenues come from firms with fewer than 100 employees. Activities range from testing a new hydraulic brake system for bicycles to developing computerized textile design. Thirty-seven such Centers existed by the end of 1986.

In addition, the Foundation has a special *Coordination Agency for Communication Technologies* which provides consultation on business communications. It sponsors a number of ongoing study groups which monitor progress in nascent fields, as well as occasional seminars and lectures. Furthermore, the Foundation is actively involved in the creation and development of 10 *Regional Technology Incubation Centers*, all of which are located near universities.

The *Fraunhofer Gesellschaft* is a nationwide organization. Approximately one-third of its funding comes from government sources (90% federal and 10% state) and two-thirds from industry. It supports *Fraunhofer Institutes.* These centers for applied research and development fall into three categories:

- basic, exploratory research, funded from government sources;

- high-risk, long-range research projects supported largely by industry, particularly larger corporations (somewhat similar to National Science Foundation (NSF) Cooperative Research Centers in the United States); and

- applied research and development projects, mostly for small- and medium-sized enterprises, carried out on a contract basis.

Most of the Fraunhofer Institutes are located near universities, with senior professional staff usually having adjunct appointments.

In recent years, additional similar institutes have been created by state funds. Baden-Wuerttemberg, for example, has established a large *Microelectronic Center* which provides expertise to assist in introducing automated techniques into existing industries.

All these Institutes, as well as the Steinbeis Centers pay university and polytechnic faculty for their services.

Both the *Chambers of Commerce* as well as a number of *Trade Associations* in West Germany are more active than their counterparts in the United States. Part of their responsibility is to assist small- and medium-sized enterprises in the absorption and utilization of new technology. For example, a large *Textile Research Center*, funded by the association of textile manufacturers, carries out extensive applied research and technology transfer activities ranging from research on new fibers and materials to the development of computer-assisted design and computer-controlled looms. In addition, the Chambers are in charge of the extensive German apprentice system. German youth who leave full-time schooling after the tenth grade receive an intensive three or three-and-a-half year, industry-based program combining ongoing classroom education with a great deal of hands-on instruction.

Every university and many polytechnics in Baden-Wuerttemberg have state-funded *contact offices*. These offices are responsible for compiling and disseminating information about the intellectual and technical resources of the institutions, providing an entry point for potential clients and facilitating the development of research contracts and other relationships.

The Need for Industrial Extension in the United States

The United States should apply its experiences with the agricultural extension system to the dissemination of today's information and technology. This could take the form of an effective *Industrial Extension System* designed to stimulate knowledge transfer and technical assistance activities in all sectors of the economy. The term "industrial extension" is used because it has gained currency through the publications of the Berkeley Business Roundtable and by speeches of President Frank H. T. Rhodes of Cornell University and others. But the need for extension is not limited to "industry"; new ideas and techniques are as urgently needed in the service sector, the nonprofit community and private enterprise.

The entire range of universities and their schools and colleges can participate. Extension needs are not limited to science and technology. Outreach activities should also utilize the latest thinking and developments in the social sciences, law, ethics, political science and sociology.

Not every university and not every faculty member needs to participate equally in this venture. Some will concentrate on basic and applied research, some will be most heavily engaged in instructional activities, while others will concentrate on collecting and disseminating new ideas and techniques. All of these are integral components of the complex flow of knowledge from creation to utilization. All are of comparable importance. With that recognition, it is possible to develop channels of communication within and among universities and colleges so that each can carry out its task most effectively.

Faculty who are not involved in basic or applied research can nevertheless play a major role in the dissemination and application of new ideas, provided adequate ways of keeping them up to date exist. Effective bridging mechanisms are needed to reach the potential clients of technology transfer. The academic system of values, incentives and rewards must reflect the critical importance and value of these scholarly activities.

Public initiatives to encourage industrial extension exist in just about every state of this country. For example, the Benjamin Franklin Partnership program in Pennsylvania provides matching funds to help support a number of Advanced Technology Centers (located at academic institutions) which conduct applied research in close collaboration with industry. In addition, Pennsylvania State University has a substantial technology extension service called PENNTAP (Pennsylvania Technical Assistance Program). At Ohio State University the Thomas Edison Program supports Technology Centers as well as an extension service called OTTO (Ohio Technology Transfer Organization). Many additional examples of applied research centers can be found in other states.

However, existing state-supported efforts in this country are still modest and peripheral to the much more publicized initiatives to foster new high-technology enterprises. Many more dollars are spent on various Centers of Excellence than on Applied Technology Centers. The need for effective transfer and dissemination mechanisms is not, as yet, widely perceived or understood by policy makers, educators or the public. Bold statements about the eventual impact of new ventures in biotechnology are more appealing and receive more attention than exhortations to modernize mature industries and services. The use of "bully pulpits" to change public perceptions and to enhance awareness of the importance of industrial extension and technology transfer may be as crucial as the provision of material support at the state and federal level.

But, rhetoric alone is not enough. Both the West German achievements as well as the few examples of effective industrial extension in this country indicate the crucial importance of an effective *infrastructure*. This infrastructure serves as a mechanism and catalyst for building relationships between academic institutions and the potential users of their technical expertise.

Two aspects in particular are important. One is to make our universities and colleges more accessible and understandable to outsiders. It is usually very difficult for outsiders to identify faculty interest and the kind of technical assistance which might be available. For outsiders to "use" an academic institution, there is a need for the equivalent of reference librarians who help non-experts to use a library. In West Germany and several other European countries, all universities and many polytechnics have a "contact office" to provide this service. A number of American universities provide similar services.

The second aspect is that effective industrial extension must take the initiative in reaching out, particularly to the smaller business and public agencies. In the area of technology transfer, these constitute the equivalent of the non-traditional student in the area of instruction. Special measures must be taken to encourage access for both. In agricultural extension, active outreach by extension agents enhances access by the small farmer and other constituencies. The equivalent is needed in industrial extension.

A New Look at Education for Competence

The major challenge of modern higher education in the United States has been the development of individuals who are competent and effective in their occupation or profession. So it remains today. Indeed, this responsibility is greater than ever because our contemporary society needs a growing number of people with increasingly advanced skills.

In recent decades this country has made great strides in terms of access to higher education. We have the highest participation rate and the highest proportion of individuals in the work force with college or university degrees among industrialized nations today. We should be in good shape. However, wide-spread dissatisfaction with the capabilities of our college graduates clearly indicates that we are not. From all sides we hear strong criticism about the kinds of education our academic institutions provide as preparation for productive careers. The contribution of higher education to competitiveness must, therefore, include a concerted effort to improve this situation.

The Quality of Education

But how? What is wrong? What needs to be done to bring about improvement? The basic quality of higher education is the most frequent and pervasive target of current criticism. Too many individuals, it is said, graduate from our colleges and universities without being able to express themselves clearly and coherently, orally or in writing. Their ability to think critically and to analyze complex situations is also questioned. As David Longanecker, Executive Director of Colorado Commission on Higher Education, emphasizes in his paper, *A Federal Role in Post-Secondary Education*, substantial improvement is obviously needed.

But one must begin with a better understanding of the status quo. All too frequently criticism is based on the erroneous assumption that higher education has somehow deteriorated from what it used to be. There existed at one time a golden age -- or so the common rhetoric would have it -- when the teaching skills of dedicated faculty ensured that all graduates were liberally educated, highly literate, knowledgeable about a shared cultural heritage and able to apply critical analysis to the issues confronting them on the job or as citizens. Such nostalgia is, at best, an idealization of the past. In that past many young people graduated from even our most prestigious institutions with an accumulation of "gentlemen's C's." This hardly reflects great educational achievement. More important is the point that in the past higher education was really not put to any pedagogic test. Most of those who entered college at that time did so with adequate basic skills and a substantial base of information and culture reflecting their relatively advantaged background. "Disadvantaged" students had to be unusually bright and hard working. As a result, academic institutions did not have to pay much attention to teaching techniques. No great feats were needed to help generally well-prepared students learn more. Even those who graduated without much effort still had a veneer of literacy and culture.

The postwar expansion of higher education broadened access and brought to our campuses a much more heterogeneous student body. Many entered college without much prior intellectual and cultural nurturing. For the first time, our colleges and universities faced real pedagogic challenges for which their faculty were -- and continue to be -- unprepared. Thus, we cannot seek to remedy the current situation by returning to some idealized past. Nor should the issue be

oversimplified in terms of the tension between teaching and research. Rather, one needs to recognize that for the first time in the evolution of modern higher education, conditions place substantial demands on the teaching skills of faculty. Today we cannot assume that all students except those admitted with educational deficiencies will acquire an education without active and constructive instruction. An increasingly heterogeneous student body brings to the classroom varying educational traditions and different motivations. Because they tend to view education as a means to an end rather than as an end in itself, *how to teach* has become as important as *what to teach*. In a very real sense, higher education today is obliged to pay explicit attention to its pedagogic challenges and should be held accountable for its shortcomings in this area. Substantial changes are needed in the mode and condition of college-level instruction. The preparation and further development of future faculty should explicitly reflect that to be in higher education is to be part of a teaching profession.

Accountability and Assessment

The pervasive criticism of the quality of higher education has, predictably and appropriately, triggered demands for greater accountability, especially in view of steadily rising costs. The demands concentrate on public colleges and universities, but the issue of accountability is being raised for the private institutions as well.

Greater accountability pressures have been exerted in the area of cost control, with questions being raised about the faculty workload as well as about the size and cost of academic administration. Legitimate questions can be raised about these, but all too often the external comments reflect inadequate information about the function and organization of academic institutions. Unfortunately, the academic community has not been very effective in its response. Instead of providing information in ways which would lead to a greater external understanding of what goes on in a college or university, there has been a tendency to take a "we are the experts; we know best" attitude. This defensiveness has been intensified by strident and oversimplified attacks on higher education emerging from the federal government. This is an excellent example of the misuse of the federal role. That role could be more constructive through a more measured insistence on academic self-examination and accountability, coupled with an equally determined effort to explain the academic enterprise to the public.

The second direction taken by the demands for accountability has been an accelerating trend toward assessment of student achievement. Again, this is both understandable and legitimate, but there are substantial dangers. One is the resulting tendency toward curricular orthodoxy and uniformity. Again, the federal role has been negative, pushing for using a fixed canon of knowledge as the touchstone of educational quality. A second danger is to take the path of least resistance by reducing assessment to standardized testing. Educational achievement is much more than, and indeed fundamentally different from, the acquisition of facts. If the trend toward testing is pursued too far it threatens to reduce higher education to a prolonged game of Trivial Pursuit. In this area, as well, there is potential for a constructive federal role to help raise the level of discourse on assessment to a more sophisticated level.

The Content of Education

Beyond the issue of inadequate basic skills, one current criticism of higher education is the view that too many students receive little more than advanced training in narrowly defined specialties. They do not acquire the breadth and the perspective associated with a liberal education. This criticism is very valid, but it is too often expressed in terms which amount to little more than a replay of the debate between advocates of a broad liberal education and those who stress the necessity of acquiring specialized expertise. Both accept the utilitarian view of education. But, on one side there are those who wish to cram ever more technical subjects into the curriculum, while the opposition tends to express the view: "Just teach them to think clearly and to express themselves well -- all else they can learn on the job." We are witnessing a renewed polarization of what should be complementary components of an integrated curriculum.

We must get off this pendulum, swinging back and forth between two equally exaggerated and unacceptable extremes. We must realize that the shortcomings of the current approach to career preparation cannot be remedied by a return to the past. General education cannot be entirely divorced from the realities of the work place, devoid of the development of technical expertise. This will not meet contemporary educational needs, but neither will narrow specialization devoid of any contextual understanding or of humanistic sensitivities. We need to take a fresh look at the educational outcomes made necessary by the complexities of modern life. We must recognize that competence on the job and in a profession -- and, competence to be an effective citizen in a participatory democracy -- has acquired new meanings and dimensions. These must become the new objectives for the educational process and new components of educational programs.

What are these new dimensions? First, expertise continues to be important, perhaps more so than ever before. The acquisition of expertise, whether in technical or in non-technical fields, requires formal instruction. It is not possible to rely on on-the-job training alone. The necessary concepts and principles must be learned in an organized and sequential fashion if they are to provide a framework for understanding.

But specialized expertise by itself is not enough for professional competence. To be an effective manager or engineer, computer expert or lawyer, private entrepreneur or public official, individuals must possess a high order of critical and analytical skills. They must have a broad understanding of the context in which they operate, and must be able to bridge the gap between the simplification of theory and the complex and ambiguous reality of practice. These needs are intensified by the trend toward decentralization and toward hierarchical organizations. Reorganizations of business and industries are pushing decision-making down to lower levels, and decision-making requires more than technical expertise.

The most recent review of undergraduate engineering education at the Massachusetts Institute of Technology (MIT) calls for a broader curriculum because "understanding the political and economic implications of technology is as important as understanding the technology itself" when making decisions. In the curriculum, non-technical subjects must be closely related to the area of specialization and become an integral part of professional competence. Simply shifting

the balance of credits between specialization and core curriculum is not enough. A veneer of general education will not do the job. Social, economic and political dimensions of practice, as well as the pertinent ethical and legal considerations must be integrated into the curriculum. Its various components must reinforce one another and combine into a coherent whole.

Another dimension of effective practice needs to be incorporated into higher education. At this time, there exists *too much of a gap between what is taught in the classroom and the reality individuals will confront on the job*. The curricular organization currently existing in almost every career-oriented field begins with the applicable basic sciences followed by applied subjects and then clinical periods to gain experience in applying the acquired theory.

As Donald Schon has pointed out in his seminal book, *The Reflective Practitioner*, this traditional, deductive model reflects the assumption that practitioners deal with recurrent problems and that these problems have a single, correct solution which can be found by applying basic theorems, paradigms and techniques. Unfortunately, real situations are not that simple. They tend to be messy and ambiguous. Each has unique components. Instead of a single correct solution there usually exist alternative approaches, each requiring some compromises and trade-offs among competing goals. Effective practice in all fields consists of *defining* the issues, and moving toward an optimal resolution through successive cycles of what Schon calls "reflection-in-action."[3]

The need to integrate "the liberal with the useful arts" and the importance of bringing the educational process closer to the realities of actual practice require a fundamentally different approach to the organization and content of career-oriented curricula.

Academic institutions must bring about new relationships and closer cooperation in program design and delivery between the faculties of arts and sciences and those in professional fields. Teaching should be more inductive, proceeding from the specific to the general. Curricula should make earlier and greater use of real and simulated clinical experiences as primary sources of learning.

These changes will place substantial new demands on faculty. They too must now have more than narrowly specialized expertise. They need to have a broad understanding of their specialty and its relationship to other fields. They must view the profession or occupation linked to their field within its social, political and economic context. They must understand the limitation of theory and its relationship to practice. And, as if this were not enough, they need not only to take teaching seriously -- something in which much progress has been made in recent years -- but, for the first time, they need substantial pedagogic skills.

3. Donald A. Schon. 1983. *The Reflective Practitioner*. New York: Basic Books.

Maintaining the Competence of Practitioners

So much has been said and written about the acceleration of change and the rapid obsolescence of knowledge that it is no longer necessary to emphasize that most employees need to continuously update their skills. Corporate spending on employee training and education is comparable to what all 50 states together appropriate for higher education.[4] A substantial "training industry" has sprung up to meet much of the resulting demand for instruction and materials. Professional associations provide a wide variety of programs for their members.

However, the full educational implications of change in contemporary society have not, as yet, been grasped. On the whole, most career-oriented education continues to be "front-loaded", and attempts to provide individuals with an understanding of basic principles, concepts and relationships expected to serve them throughout a lifetime of professional or occupational practice. Change is assumed to be limited to details: new techniques, new materials, new laws and regulations and new data. As a result, continuing education provided for employees and for self-employed professionals falls into the category of "quick-fixes." Short seminars and workshops deal with industry-specific technological innovations, new products and production methods and changing policies and regulations.

The overall pattern of higher education continues to be one in which the permanent structure is created before an individual enters a job or begins practicing a profession. As details change and innovations occur, appropriate ongoing repairs are made, some parts are replaced and an occasional coat of paint is provided; but the structure remains basically unchanged.

This traditional approach needs to be changed. It does not adequately reflect the extent to which details of application, basic theories, paradigms and principles themselves are changing. These changes are occurring in the specialized core of a profession or occupation, as well as in the contextual understanding needed to be competent and effective in the practice of a profession or an occupation. These essential intellectual foundations can no more be "front-loaded" than can the many technical and other details. These, too, must be updated and renewed on an ongoing basis throughout an individual's career. In effect, the professional development of an individual must become like an ongoing restoration process. The original structure is at times expanded, at times modified, but continuously changed.

This need was expressed very well in a report issued by MIT's Electrical Engineering and Computer Science Department a few years ago:

> The rapid rate of scientific and technical progress challenges a basic assumption on which traditional engineering education is based: that a few years of formal education can provide an adequate foundation for half a century of professional work. More specifically, it has been assumed that new technological developments, with which an engineer would have to become familiar after graduation, would be extensions of previous ones, or at least based on the same scientific and mathematical knowledge. This has not been true for a number of recent technological developments and is not likely to be true in the future. Thus, [practicing] engineers are faced

4. cf., e.g. Ernest A. Lynton. 1984. *The Missing Connection Between Business and the Universities*. New York: ACE/MacMillan.

> with the problem of learning, during their professional lives, what new generations of engineering students are currently learning in school.[5]

In short, continuing competence requires an ongoing process of learning new fundamentals in one's own field as well as related disciplines. Short courses focusing on new specialized knowledge are not enough. The MIT report points out that the pace and the extent of change is such as to affect "...the very style and language of engineering" several times during a person's career. Hence, practicing engineers must have repeated opportunities to keep up with basic developments. What is true for engineering holds true for most other professions and occupations.

Higher Education and Continued Training

Higher education should concentrate on meeting the resulting developmental task. To date, colleges and universities have played only a limited role in the professional and employee continuing education. Even when they have been involved, they have done so with much uncertainty and confusion about their role. Anxious to compete in a seemingly lucrative market, many academic institutions have plunged into providing quick updates of skills and factual knowledge, matters which are more training than education. It is doubtful that this instruction is appropriate for colleges and universities. Employers themselves or third party providers are, on the whole, in a better position to offer this kind of short-term training. Instead, universities and colleges should tackle the challenging developmental needs generated by changes in the knowledge, skills and understanding needed for competent practice, i.e., the basic principles, theorems and methods of the occupational specialty, as well as its social, political and economic context. It is that kind of learning for which institutions of higher education are most -- indeed perhaps uniquely -- qualified. The criticism of the "quick fix" by short courses and workshops is based on content, not format. Indeed, the format of fairly short courses, requiring limited attendance during working hours, is the only realistic approach to guarantee employee participation in continuing education. Few self-employed professionals can afford repeated, prolonged absences from their practice; fewer employers will support this instructional pattern for their employees.

Thus, the challenge to higher education is to develop a modular approach using short periods of instruction to allow participants to keep updating theoretical and conceptual knowledge.

The more our colleges and universities are able to provide ongoing renewal, the more it becomes possible to reexamine content, organization and length of the preparatory phase of what becomes a lifetime process of career-oriented education. If opportunities for systematic and recurrent renewal exist, there is no longer as much need to cram more and more into the initial educational phase. That first educational stage needs to contain only information enabling an individual to function effectively at the entry level; additional development can occur after practice has begun.

In a sense, recent years have witnessed a remarkable move toward that model in engineering and management. With economic realities causing more young people to accept jobs with a

5. James D. Bruce, *et. al.* 1982. *Lifelong Cooperative Education.* Cambridge: MIT, p. 11.

baccalaureate degree, continuation toward a master's degree on a part-time basis has become increasingly common. Indeed, one can describe the emerging normative educational pattern in those two fields as consisting of a first, full-time phase followed by a second part-time one; the two together lead to the first professional degree at the master's level.

Further demands are made on faculty teaching older students who bring to the classroom many years of practical experience. Such teaching is often done in a modular basis, and in formats, at times and in locations very different from the customary ones. But the new modes and areas of faculty involvement -- industrial extension, modified approaches to career preparation and continuing professional education -- are mutually reinforcing and complementary. Involvement in any one will make it easier to be involved in the others.

New Demands on Faculty

Each of the major changes in higher education places substantial new demands on college and university faculties. Fortunately, the three changes necessary to enhance higher education's contribution to economic competitiveness are closely interrelated and mutually reinforcing.

The more faculty members engage in technology transfer and the more familiar they are with its application, the better they will be able to prepare their students. Similarly, faculty involvement in continuing education brings them into direct contact with individuals who have been engaged in practice. This improves the faculty's effectiveness in their preparatory teaching and their ability to contribute to technology transfer. These three activities are interrelated parts of a general move toward making colleges and universities closer to their constituencies and the world around them by a two-way flow of communication and activity. The result is a closer tie between theory and practice, teaching and experience.

This logical coherence and mutual reinforcement of the desired changes makes it possible to view the new demands on the faculty in a correspondingly integrated fashion. Whether faculty members are teaching undergraduates, contributing to continuing professional education or engaging in technology transfer, they must be familiar with the realities of practice. They must have some understanding of the broad knowledge a practitioner needs to be effective. By the same token, faculty in the arts and sciences need to understand the relevance of their field to the future or current practitioners in their classrooms, and to the clients of knowledge transfer in their extension activities

Strong institutional activity in a variety of extension and technology transfer activities allows students to be directly involved. If more emphasis is given to providing clinical experiences for students at an early state on their career-oriented preparation, contacts between faculty members and practicing professionals will increase. This will aid faculty to understand external conditions and lead to opportunities for extension activities.

Continuing education and technology transfer cannot be separated. The professional assistance needed in the absorption of technological and organizational innovation almost inevitably involves a good deal of teaching extending well beyond narrow training in the operation of a

specific new gadget. New technology management has emerged as a major area of competence, the absence of which often inhibits the effective absorption of innovation. Automation of machinery and new information systems more often than not involve organizing work differently, new responsibilities and different, often shifting relationships among individuals. An essential part of technology transfer is providing the mentoring necessary to bring about these changes.

In addition to the demands placed on faculty to link theory and practice in teaching and transfer activities, substantial new pedagogical challenges exist. *How to teach* has joined the question of *what to teach*. There is a striking near-congruence between preparatory teaching, providing continuing education and involvement in extension and transfer. They all require an inductive approach, proceed from the specific to the general, and integrate simultaneous or prior experience into formal instruction. Increasingly, all these activities involve teaching mature and experienced individuals.

These new demands add up to a formidable challenge which cannot be left to the casual, on-the-job training relied on in the past to supply all necessary faculty skills except narrowly defined subject matter expertise. Faculty must systematically acquire a broader understanding of the subject, and the necessary pedagogical skills. Just as there are new dimensions to competence for effective practice in other professions, there are additions to the competence needed for the academic profession. These new qualifications must be integrated into the ongoing professional development of existing faculty as well as the preparation of the future professorate.

The Federal Role — Industrial Extension

Industrial extension differs from the traditional agricultural extension activities in that it can, in most cases, obtain user fees for its services. However, two elements require up-front funding: a basic infrastructure of contact offices and a core staff; and the ability to provide a preliminary level of diagnostic analysis and technical assistance before charging user fees.

In the limited number of cases where some systematic industrial extension program has been instituted, the state has funded these needs. The principal focus at the state level should probably be kept, but there would be considerable advantage to have federal funding as well. Such federal participation is likely to trigger activity in those states which have not created extension activities and will enhance the scale of existing programs.

It is entirely appropriate and consistent with current policy for the federal government to play an active role in stimulating and supporting industrial extension. Since World War II, these have been matters of great federal concern and have received substantial direct federal support: scientific and technological advances, and broad access to knowledge. The former has been fostered by substantial federal funding for basic and applied research; the latter by a variety of student financial aid programs. Industrial extension bridges the two activities by bringing research results to potential users and helping them to understand and to apply such innovations.

Such extension constitutes, in a very real sense, another form of education. Reaching out to external constituencies, particularly small- and medium-sized companies and agencies, is an equally important element in the issue of access.

Agricultural extension services are well-established precedents as are the federally funded programs of Small Business Development Centers. The SBDC, a network of technical assistance centers, uses expertise from higher education to help small companies with management and financial problems. Indeed, the SBDC might well serve as a framework for the kind of infrastructure needed for an effective industrial extension program.

In addition to providing direct support to state-based extension programs, the federal government can also play an indirect role by appropriate tax policies, such as ensuring tax exemption of corporate contributions to technical assistance centers.

Education for Competence

The great potential of the federal government to set the education agenda was strikingly demonstrated by the impact of the report, *A Nation at Risk* which drew nationwide attention to the quality of secondary education. The subsequent publication of *Involvement in Learning* triggered additional discussion about the nature and the quality of higher education, and also raised questions of assessment and accountability. Both examples illustrate the importance of the "bully pulpit," too often ignored in discussions of the federal role.

The federal government can continue to play an exhortatory and agenda-setting role in this fashion, and should do so. Pressure must be maintained on all appropriate constituencies within and without the academy to monitor educational outcomes. However, this federal advocacy role must be exercised with some discretion and a great deal of judgment, lest exhortations become prescriptions.

Too much pressure may result in solutions arising from the path of least resistance. In academic matters, this can occur in two ways. One is to measure quality of education by performance on standardized, quantitative tests. The other is to define a fixed, finite canon of materials as the essential core of knowledge, without *all* of which no one can be truly educated. The last thing this country needs today or in the future are rote learners who have plowed through the same reading list. Yet we have moved dangerously far in that direction.

We are now facing a very real dilemma. On one hand, the call for greater quality assurance is completely justified and of unprecedented importance. But at the same time higher education is facing major pedagogical challenges which require innovation, new approaches, risk taking and possible failures. The latter calls for diversity; the former is not easily carried out under conditions of uniformity. Considerable wisdom will be required by those at the federal level to strike the necessary balance.

The Fund for the Improvement of Post-Secondary Education (FIPSE) has been one of the most effective sources of support for educational experimentation and innovation, and one of the best

examples of a direct federal role in higher education. Its efforts should be enhanced and its funding increased.

The issue of knowledge transfer and extension exists within higher education just as it does in the public and private sectors. New ideas and techniques need to become widely known among colleges and universities if they are to have impact. To some extent, these are spread through national and regional meetings of higher education associations, as well as by personal contacts. Yet, only a small fraction of institutions and individuals benefit from this form of dissemination. Many faculty members and administrators, particularly those smaller and less influential institutions, feel isolated, and do not receive timely information about new educational innovations.

One possible solution to this problem would be to use federal funds to establish a series of academic extension centers located at colleges and universities. Such a center would be responsible for dissemination of innovations in higher education on a regional basis. It could publish a newsletter and occasional papers, sponsor regional meetings and workshops on important current issues and developments in higher education and provide technical assistance for both individual and institutional development. These center would be linked together in an informal regional network.

Access to Continued Training

The United States is one of the few industrialized countries without some kind of national policy regarding access of the labor force to the lifelong training and education required to maintain skills and understanding. To develop such a policy will not be easy; existing foreign models are not entirely satisfactory. But failure to develop such a policy will adversely affect the competence of our workforce.

There is no systematic way to ensure participation by all levels of the work force and all categories of employers. Participation in continuing professional and occupational education is skewed toward senior management in business and industry and the more affluent professions. An individual employed by a small business or someone practicing a fragmented and not well-organized profession is less likely to have opportunities to update his or her expertise. But the need to cope with rapid change and update skills exists at all levels, in all occupations and in all kinds of enterprises. Indeed, it may be important to the small business or agencies where one employee is responsible for many facets of the operation.

Access to education has been, for several decades, a matter of federal policy. Originally conceived on the basis of equity and social development, access to education increasingly is recognized in terms of its economic impact as well. Education must be viewed as a lifelong process. It therefore follows that access to life-long education is a matter of federal concern and requires of appropriate federal policies.

However, the policy issues associated with continuing professional and occupational education differ from those connected with access to undergraduate and graduate education. In the latter, the principal federal role is one of direct financial support through grants and guaranteed student loan programs. The individual's ability to pay is not the central problem of access to continuing education by employees and practicing professionals. Rather, it is the lack of personnel qualified to make assessments about the quality and appropriateness of training and issues concerning release time.

Most small organizations cannot support human resource development staff. Many may not even have a full time personnel manager. Such an operation, therefore, either pays no attention to staff developmental needs, or if it does, is entirely dependent on ready-made, externally provided instructional packages. It may be difficult to judge the quality and appropriateness of this material, because no one in the organization is a member of the American Society for Training and Development or has access to other networks of experts.

There is no simple answer to this problem. But the situation would be greatly improved by the creation of an infrastructure very similar to an industrial extension program. Offices and the equivalent of "extension agents" could provide information and advice regarding available and appropriate materials for employee education. Because there exists an element of instruction and human development in technology transfer and industrial extension, it would make sense to develop a single infrastructure to foster both the informal instruction implicit in knowledge transfer and the more organized instruction needed for continuing education.

There is a second, and perhaps even more basic, problem associated with providing human resource development opportunities in small enterprises. Many of them believe that they cannot afford any appreciable amounts of released time (an issue of increasing importance, as well, in the ever more tightly managed larger companies). More fear the loss of their investment if a trained employee leaves to work for a competitor.

This issue has received major attention in other countries. Usually, all employers contribute on a sliding scale to a pool available for employee education. None of the existing schemes are entirely satisfactory, but at the least a federal policy approach tailored to the conditions in this country should be explored.

Faculty Development

Major opportunities exist for federal assistance to encourage professional development of faculty. The federally-financed summer institutes created under the original National Defense Education Act is a precedent. Such institutes, together with orientation periods in a practice setting, could expose faculty members to the complexities of actual teaching situations. These institutes would enhance the pedagogical competencies and skills of faculty members.

A second activity which could benefit from federal support -- on a matching basis -- would be the creation of faculty internships in the public and private sectors. Initially the federal government could establish such internships within its own agencies and departments.

These internships would help prepare and broaden future faculty; they already exist in law, engineering and medicine. Much could be gained by incorporating similar opportunities into the Ph.D. programs of future professors. A category of post-doctoral fellowships -- financed jointly by the federal government and the temporary employer -- could be created whereby future professors could gain practical field experience before assuming their teaching duties.

Conclusion

At this time, higher education is far from fully contributing to the economic well-being of this country. Much more can be done without the loss of autonomy. The changes required are fully compatible with the unique character of American universities that combines utilitarian educational goals and responsiveness to societal needs with the independence, detachment and long range perspective.

To date, discussions of higher education's contribution to American competitiveness has focused on cooperation between leading research universities and industry in basic and applied research. That is important, but not enough. The role of colleges and universities in economic development can be enhanced in three ways:

- by developing a system of "industrial extension" centers to mobilize university and college resources to improve the dissemination of new knowledge and transfer of new technology from the research labs to the shop floor and office;
- by making substantial changes in the way engineers, managers and other professionals are prepared for their careers; and
- by developing more systematic and widespread access to continuing professional education to keep up with technological and other changes.

These tasks for higher education require attention and action at various levels: within the academic community and by state and federal government. This paper suggests the following federal roles:

- providing seed money and appropriate tax policies to stimulate the development of local and regional systems of "industrial extension;"
- enhancing federal support for educational experimentation and innovation in career and professional education;
- providing seed money for the development of "academic extension" centers to disseminate new educational ideas and approaches to the academic community and provide opportunities for appropriate faculty development;
- undertaking a systematic exploration of a national policy, including, but not limited to, tax issues, access of the labor force to lifelong training and education, with emphasis on small- and medium-sized enterprises; and
- using the "bully pulpit" available to federal officials to increase awareness of these issues within industry, government and the academia.

The role of higher education described in this paper should supplement the fundamental issues cited in the paper by David Longanecker. If broad access to post-secondary education is not enhanced, and if the quality of education is not approved across the board, then we might indeed, as Marc Tucker has said, be "building a castle of professional and managerial competence on a foundation of sand."

All three new tasks of higher education are related; they reinforce one another and pose a common challenge to the faculty. They compromise a model for the university of the future, one in constant interaction with its surroundings. This new university is a multi-faceted source of innovation and ideas for all of its constituencies. It is actively involved in making sure new knowledge is disseminated to potential users, understood and can be applied by them.

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